II. "An Experimental Investigation of the Nerve Roots which enter into the formation of the Brachial Plexus of the Dog." By J. S. Risien Russell, M.B., M.R.C.P. Communicated by Professor Victor Horsley, F.R.S. Received February 18, 1892.

(From the Physiological Institute of Berlin and the Pathological Laboratory of University College, London).

(Abstract.)

The subject is introduced by an allusion to the attempts that have been made by anatomists to determine the functional relationships between the nerve roots and groups of muscles they supply, in which connexion the work of Krause, Schwalbe, Herringham, and Paterson are cited. A brief reference is made to the observations of Erb, Duchenne, Knie, and Thorburn, after which the author refers to the experimental work that has been done in this field by Müller and Van Deen, Kronenberg, Panizza, Peyer, Krause, Ferrier and Yeo, Bert, Marcacci, and Forgue. The anatomical accounts of the brachial plexus of the dog as given by Ellenberger and Baum, Chauveau and Arloing, and Forgue are quoted, the discrepancies which exist between these different accounts pointed out, and the author's own experiences in this connexion, differing in some points, while agreeing in others, with the descriptions given by these observers, are detailed.

He then proceeds to explain his methods of experimentation, which consisted in:—

1. Observation of the compound movements in the fore limb of the dog by electrical excitation of the peripheral end of the whole of a cervico-brachial nerve root which had been previously exposed and divided.

2. Minute differentiation obtained by electrical excitation of the individual bundles composing such a nerve root.

3. Direct observation (after dissection) of the muscles thrown into action by electrical excitation of the separate nerve roots. As a corollary to this, the question as to whether or no a single bundle of fibres representing a single simple movement in a nerve root ever remains distinct in its course to the muscles it supplies, without inosculating with other nerve fibres, is dealt with. A further point determined is whether, when a muscle receives nerve fibres from more than one cervico-brachial nerve root, both nerve roots supply fibres to one and the same muscle fibre or not.

4. Alteration in the action of the fore limb in progression or in standing, evoked by section of a nerve root or roots.

5. Influence of section of a root or roots in excluding part of a

generalised epileptic spasm induced in the limb by cortical excitation.

6. Differentiation of parts of the nerve roots by the degeneration method, in which connexion an allusion is made to certain results obtained by the author, which do not accord with the Wallerian law of degeneration, and which are in accord with the experiments of Joseph.

From the results of these various methods of experimentation, the author draws the following conclusions:—

I. *Stimulation Experiments.*

1. The compound movement obtained by stimulation of a whole nerve root is a well-coordinated one, depending on the action of a group of muscles in synergic combination, as Ferrier and Yeo showed to be the case in the monkey.

2. This compound effect may be resolved into its component factors when it is found that movements diametrically opposed to each other may be represented in the same nerve root, *e.g.*, flexion and extension.

3. Such single simple movements bear a constant relation to the nerve roots, the same movements being always found in any given root, and thus such movements always bear the same relation to the spinal level; *e.g.*, flexion of the elbow is always represented one root higher than extension of the same joint.

4. Fibres representing a certain movement always preserve the same position in a given nerve root; *e.g.*, extension of the wrist is represented by a bundle of fibres in the upper part of the circumference, while flexion is represented by a bundle of fibres in the lower part of the same root.

5. Each bundle of nerve fibres representing a single simple movement in a nerve root remains distinct in its course to the muscle or muscles producing such a movement, without inosculating with other motor nerve fibres.

6. The group of muscles supplied by any given nerve root occupy both the anterior and posterior surfaces of the limb. In other words, muscles whose unimpeded action would produce one movement are represented in the same root as others whose action would produce a movement diametrically opposite.

7. In such combinations certain muscles are always more extensively represented than others, so that, with a current sufficiently strong to stimulate all the fibres of a nerve root equally, certain muscles predominate in their action over others.

8. The muscles whose action predominates in one root always predominate in that root.

9. If the muscles producing flexion of a certain joint predominate

in their action in one root, those producing extension predominate in another.

10. It is possible, by stimulation of a single bundle of fibres in a nerve root, to produce contraction of a single muscle, and it alone.

11. The same muscle is always represented in more than one nerve root, usually two, and to an unequal extent in these.

12. When the same muscle is represented in two nerve roots, the muscle fibres innervated by one root are not innervated by the other.

II. *Ablation Experiments.*

1. Division of any given nerve root produces paresis of the group of muscles supplied by it.

2. This paresis is only temporary, and soon passes off almost completely.

3. Such division of a nerve root does not result in incoordination of the remaining muscular combinations represented in other nerve roots.

III. *Exclusion of a certain Root or Roots during an Epileptic Spasm in the Limb (the root being divided at the time, and not some time previously).*

1. Division of one or more nerve roots produces alteration of the position of a limb during an epileptic spasm, which altered position depends on the particular muscular combinations that have been thus thrown out of action.

2. No incoordination is produced in the action of the remaining muscular combinations.

3. There is no evidence of overflow of the impulses which ought to travel down the divided root into other channels through the spinal centres, so as to reach the muscles by new paths.

IV. *Degeneration Method.*

1. These experiments confirm the anatomical facts that had been previously ascertained by dissection, as to which nerve roots supply any given nerve with fibres.

2. The degeneration which results in the nerves is not a scattered one, but is localised to distinct bundles of nerve fibres occupying a certain position in the transverse section of the nerve.

3. The Wallerian law of degeneration is found to be erroneous with regard to the degenerations which result on division of a nerve root on the distal side of the intervertebral ganglion; for not only is degeneration found in the peripheral end of such a root, but also in that portion of the sensory root between the ganglion and the spinal cord;

pointing to the probability that there are certain nerve fibres which do not depend on the ganglion for their trophic supply, but derive the same from elsewhere, either the spinal cord at another level, or the periphery.

In conclusion, the author calls special attention to the value of the method of excluding one or more nerve roots during an epileptic spasm, as affording a means of confirming the facts that have been previously observed from stimulation of the nerve roots, and also of ascertaining new facts with regard to them and the plexuses which they form. He further goes on to point out that it supplies a valuable means of studying the manner in which conduction of impulses from the cortex through the nerve roots and plexuses to the muscles takes place; and that it is capable of still wider extension, as if, instead of producing general epilepsy, less powerful stimuli be applied to the centres for different movements, as represented in the motor cortex, it will afford a means of connecting such centres, or parts of these, with the nerve roots to which fibres proceed from these cortical motor centres.

III. "The Influence of the Kidney on Metabolism." By J. ROSE BRADFORD, M.D., D.Sc., Fellow of University College, London, Assistant Professor of Clinical Medicine at University College, Grocer Research Scholar. Communicated by Professor SCHÄFER, F.R.S. Received February 18, 1892.

(From the Physiological Laboratory of University College, London.)

The results described in this preliminary communication were obtained in a series of experiments commenced in June, 1889, and at present still in progress, with the object of elucidating the functions of the kidneys, and to gain an insight into the disturbance produced in the economy by disease of these organs.

Method.—All the experiments were made on dogs, and a complete experiment involves the following stages:—

Firstly.—The animal, after being weighed, is placed in a suitable chamber, and fed on a weighed diet containing a known quantity of nitrogen; the water drunk is also measured. The amount of urine passed is measured, and the quantity of urea and total nitrogen in it determined. Finally, the weight of the fæces and the amount of nitrogen in them are also determined. All the nitrogen determinations were made by means of Kjeldahl's method; the urea was estimated by the hypobromite method. A daily determination of the above factors was made for a period of a week, and a daily average